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Wing-warping aircraft makes first flight at Edwards

by Larine Barr, AFRL Public Affairs

WRIGHT-PATTERSON AIR FORCE BASE, Ohio — An experimental flexible-wing jet made its first flight Nov. 15 from NASA's Dryden Flight Research Center at Edwards Air Force Base, Calif.

During an hour-long test, the modified Navy F/A-18A took off, climbed to about 30,000 feet and flew a semi-race-track pattern over a test range northeast of Edwards AFB. NASA reports that the aircraft had a good first checkout flight and all test points on the cards were met.

The Air Force Research Laboratory, Boeing's Phantom Works and NASA Dryden collaborated on the research effort, called the Active Aeroelastic Wing (AAW) program, which is researching lighter weight flexible wings to improve maneuverability of high-performance military aircraft. According to Dryden's project manager Denis Bessette, the project intends to demonstrate improved aircraft roll control through aerodynamically induced wing twist on a full-scale manned supersonic aircraft.

The research builds on work begun nearly 100 years ago by the Wright Brothers, using their wing-warping control system on the 1903 Wright Flyer. "The Wright Brothers recognized that warping their wing would provide a benefit in controlling their aircraft, since ailerons had not been invented," said Air Force AAW program manager Pete Flick, AFRL Air Vehicles Directorate. "They accomplished this by pulling on a set of cables, which twisted the wing tips."

Like the Wright Brothers, the AAW inventors recognized that today's aircraft could benefit from wing twist. "With AAW, leading and trailing edge control surfaces are deflected, which causes a change in the aerodynamic pressure distribution on the wing's surface causing it to warp or twist. The surfaces are deflected such that the wing twists into a shape that helps the wing perform better than if it did not twist at all," said Flick.

The new wing technology is important to the Air Force because it represents a new approach to designing wings that are more efficient structurally, aerodynamically, and from a control effectiveness standpoint, Flick said.



An experimental F/A-18 with flexible wings takes off on its first test flight Nov. 15 from NASA Dryden at Edwards AFB, Calif. (NASA Dryden photo)

"AAW is applicable to a wide variety of future air vehicle concepts that are under study and not just applicable to supersonic flight," said Flick. "While the technology was conceived during a supersonic fighter aircraft design study, aircraft that fly subsonically can also experience a high degree of wing deformation, and therefore could benefit from the AAW design approach. Since AAW exploits wing flexibility, it also is viewed as a first step toward future 'morphing' wings that can sense their environment and adapt their shape to perform optimally in a wide range of flight conditions."

The first flight followed a three-year period of modification and ground tests at the NASA facility. The test bed aircraft was modified with additional actuators, a split leading edge flap actuation system and thinner skins on a portion of the upper wing surface that will allow the outer wing panels to twist up to five degrees. During the maiden flight, NASA research pilot Dana Purifoy put the aircraft through an extensive functional checkout covering aircraft flight controls, avionics systems, engine operation and newly installed test instrumentation.

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“This flight was basically designed to ensure the aircraft and all of its systems are working properly. The pilot also is beginning to clear the aircraft for the flight conditions that we intend to investigate during later flights,” said Flick.

With the first flight completed, the team will take the aircraft through about 30 to 40 parameter identification flights over a three to four month period. Boeing’s Phantom Works will use data from the first flights to refine wing effectiveness models and design the AAW flight control software. NASA expects the second phase of the research flights with the new control software to begin in mid- to late 2003.

“This first flight milestone is one we’ve been waiting for, and it’s only the beginning of a new chapter that combines aerodynamics, structures and flight controls into a single integrated system,” said Bob Krieger, president of Boeing Phantom Works. “Our AAW teaming with NASA and the Air Force is unique, and everyone has worked very hard to reach this point. I look forward to the next few months when we will verify this concept with additional AAW flight tests.” @